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METHOD OF SELECTING ANALOGS IN LONG-RANGE WEATHER FORECASTS

L. A. Vitel's

In long-range weather forecasts, we assume that large-scale processes exist in the atmosphere and develop regularly over a number of months. The long-range forecast is difficult because processes that develop after the forecast are continuously imposed upon the main process. Since we cannot determine this complex process and picture its future development from accurate calculations or strict physical considerations, we must, at present, turn to a more elementary method, i.e., the selection of analogs. This approach is used widely by the B. P. Mul'tanovskiy school and also in various other methods.

While working in the Division of Long-Range Forecasts, Central Forecasting Institute, the author introduced and tested several devices for making the method of selecting analogs more accurate and objective. All of these made use of data on characteristics and anomalies of pressure conditions compiled by the author for a 40-year series (1900 - 1939) from the synoptic catalogue. World War II showed the usefulness of these methodological refinements.

The method of selecting analogs by pressure characteristics was revised and improved in 1947 and used to construct an experimental forecast for the spring and summer of 1947. The basic principles of this method can be extended to other meteorological characteristics and, in our opinion, can be used in any method which makes use of analogs.

In this paper, the selection of analogs is considered without regard to other climate and weather characteristics. In drawing up experimental forecasts to check the potentialities of the method, the characteristics of the pressure-circulation conditions introduced by the author were also used exclusively. In operational practice, these characteristics would naturally be combined with others, e.g., the seasonal trajectories of cyclones and anticyclones, pressure distribution and temperature anomalies, etc.

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The basic problem in analog selection is the decision regarding what may be considered an analog. Only a clear definition will eliminate subjectivity in the evaluation of analogs.

Does the definition of analogs accepted by the Mul'tanovskiy school satisfy these requirements?

Analogy, as a relative concept, is correctly emphasized in Principles of the Synoptic Method of Long-Range Weather Forecasting, by T. A. Duletova, S. T. Pagava, A. A. Rozhdestvenskiy, N. A. Shirkin; edited by S. P. Pagava, Leningrad/Moscow, 1940, in the following words: "In some cases, two processes may be considered analogous, and in other cases, not analogous, depending on the requirements imposed on the analogs."

What are the requirements imposed on analogs? This problem can be solved only if the limits of deviations, at which an object which was an analog in the past ceases to be one in the future, are accurately established.

We find no solution of this problem in Principles of the Synoptic Method of Long-Range Weather Forecasts, and as far as we know, no one has worked on it. The authors of the above-mentioned volume defined analogs without indicating the practical basis for their definitions and the definitions thus obtained are purely conditional. In a number of cases, conditional definitions are fully permissible and can be used if one absolutely compulsory rule is obeyed, i.e., the definitions must be so clearly formulated that any ambiguity in their interpretation is excluded and any snyoptic meteorologist will come to one definite conclusion.

According to the authors of Principles of the Synoptic Method of Long-Range Weather Forecasts "Two synoptic seasons are considered to be analogous if the development of atmospheric macroprocesses and seasonal weather characteristics in these seasons are analogous." To clarify this definition, they further state: "The development of atmospheric macroprocesses in two synoptic seasons is considered analogous if the changes into seasons, the prechange and the postchange phases, and the sequence of the transition from one combination of action centers of the atmosphere to another in these seasons is analogous." "Seasonal weather characteristics in two synoptic seasons are considered analogous if the following are analogous: (a) the spatial distribution of the sign of the air temperature anomaly and the amount of precipitation, and (b) isochrones of debacle or freezing of rivers, and times and nature of establishment and departure of the snow cover, depending on the season."

According to these definitions, a general characteristic is reduced to analogs of partial characteristics but is not clarified completely. The analogousness of seasons is determined from the character of macroprocesses and weather characteristics and the analogous character of macroprocesses and weather characteristics is determined from the analogousness of changes, phases, and other characteristics; but nothing is said as to how to determine the analogousness of the latter. The problem remains open and is solved arbitrarily.

In practice, as is indicated in the above-cited volume, the selection of analogous synoptic seasons should begin with the selection of analogs from the seasonal trajectories of anticyclones. It might appear that when the definition of the analogousness of seasons is reduced to selection of analogs by trajectories of anticyclones and other concrete characteristics, the problem of analogs is simplified and is solved uniquely in all cases. Experience has shown, however, that subjectivity in the selection of analogs from seasonal trajectories is no less, and may even be greater, than in the evaluation of other characteristics.

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Let us imagine the course of an operation in selecting analogs for a map of trajectories. A photo-atlas of the seasonal trajectories of anticyclones, containing maps from 1881 to 1933, is usually used for this purpose.

We note first of all that the maps in this atlas for the separate years are not comparable since they were drawn up by different authors and the synoptic data used differs in completeness. On some maps, we find only the most basic trajectories, while others have an enormous number of lines showing the paths not only of the main centers but also very weak nuclei and ridges. However, we will assume that all maps without exception were drawn up by one synoptic meteorologist from homogeneous data and are thus fully comparable. Subjectivity in selecting analogs will still be present. In evaluating analogousness, the synoptic meteorologist must deal with the most essential characteristics and subjectivity again crops out, e.g., one synoptic meteorologist considers the paths of polar anticyclones the most important trajectories in determining the nature of the season, while another gives decisive importance to Azores nuclei for the given season, etc. Assuming further that all have agreed on the predominant importance of polar trajectories, disagreement still arises in evaluating the role of various axes. If we have a fortunate case, where the main trajectories of a season are so sharply defined that there is no doubt about their decisive role, analogs are selected only for these trajectories. It would seem that there could be no further disagreement in evaluating analogs, but even here various solutions of the problem are possible, e.g., some synoptic meteorologists will emphasize frequency of intrusions (number of trajectories) and others their spread (length of trajectories). Furthermore, there are problems related to the dates of intrusions, their intensity, etc.

As a result, the same year may be considered a good analog by one synoptic meteorologist and a nonanalog by another. The author knows of cases where the same synoptic meteorologist arrived at opposite conclusions after twice evaluating one map. This condition holds true for comparison of distribution of anomalies, especially in precipitation maps.

Synoptic meteorologists, not having clear and definite, although conditional, bases for evaluating analogs, finally begin to argue heatedly about the "fundamental concept" of the process, and in discussions on the concept of the process, subjectivity runs rampant.

One might think that such a simple problem as the selection of analogs from characteristics expressed by definite numbers would be purely objective. Even here, however, conditions are no better. For example, let us select an analog for the date of a seasonal change. Years with exact coincidence of the dates are analogs, of course. Probably no one will object to considering as analogs years differing by 1 or 2 days. Now what if the difference in dates reaches 3, 5, 7, or 10 days? Where is the boundary line at which an analog becomes a nonanalog? There are many different opinions on this problem and thus no general approach to its solution.

As a result, there is so much subjectivity in selecting analogs, the most important process in drawing up a long-range forecast, that any confidence in its correctness is destroyed. How can we eliminate this subjectivity?

The first requirement is clarification of definitions of analogousness. The more precise these definitions, the more objective is the selection of analogs. It would be completely objective to evaluate analogousness from the standpoint of characteristics expressed by number. In these cases we would always set up a definite condition. For example, years in which the date of occurrence of a given phenomenom deviates from the date for the given year by no more than n days would be considered analogs. Division of all years into analogs and nonanalogs in this way would be completely objective but naturally very conditional, since we have no real basis for considering a year with a deviation of n days an analog and those with deviations of n+1 or n - 1 days a nonanalog. Conditions objectivize evaluation, but clearly illogically.

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Does analogousness have to be defined this way, i.e., must a year, season, etc., be either an analog or a nonanalog? The instructions of the Division of Long-Range Weather Forecasts, Central Forecasting Institute, call for just such a solution of the problem. This solution is to be effected successively in each stage of the analog selecting operation, and the analysis of rhythms or periods is based on this principle.

In attempting to determine the correctness of this approach to the problem of analogousness, it is instructive to recall that Engels wrote of a similar "either-or" problem:

"For the stage of development of natural science, where all distinctions are blended in intermediate degrees and all contrasts change into each other through the agency of intermediate members, the old metaphysical method of thinking is clearly insufficient. Dialectics, which knows no hard and fast lines and unconditional 'either-or' applicable everywhere, but which acknowledges in pertinent cases 'both this and that' along with 'either-or' and expresses contrasts indirectly, is the natural method of thinking corresponding to the present stage of development of natural science," (Engels, Dialectics of Nature, 1941 edition, p 169).

"In two different things," Engels wrote further, "there are always well-known common qualities (at least the property of corporeity); other qualities differ in degree and, finally, other qualities may be completely absent in one of these things" (ibid. p 186).

Consequently, setting up analogs as absolutely opposite to nonanalogs is metaphysical.

A sharp boundary can be drawn between analogs and nonanalogs only with respect to some one characteristic and then must be qualitative, for an abstract solution of the problem. Under actual conditions, any object is characterized by a whole set of characteristics and an "either-or" solution of the problem of analogousness can only be purely conditional.

With regard to the meteorological characteristics of any time interval (year, season, month, etc.), we must remember that we can select neither absolutely similar nor dissimilar time intervals. Dialectically, we must always speak of a greater or lesser degree of analogousness.

Thus, in evaluating the analogousness of any group of objects with respect to a given one, we did not divide this group sharply into analogs and nonanalogs, but instead placed all members of the group into a series according to ascending or descending degrees of analogousness. This is the first major difference between our approach to evaluation of analogs and that used by the Mul'tanovskiy school. This approach requires the development of an objective criterion for determining the degree of analogousness. Each element subjected to such a comparative evaluation naturally has its own special features and thus it is impossible to develop a universal scale applicable to any object. At the same time, it is desirable to establish one general principle for the evaluation of analogousness which would permit one to compare the evaluation of various characteristics and derive the resultant evaluation.

We have attempted to evaluate analogousness by the deviation of a given characteristic in the analog from its value in the year with which comparison is effected for all the quantitative characteristics involved in the selection of analogs. We designate this deviation as Δ_i, where i is the number of the analog year.

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To evaluate analogousness, we do not use the quantities Δ_i directly, but relate them to the perennial amplitude of the given characteristic, which gives the maximum possible deviation. We designate this amplitude Δ_{max}.

We call the ratio of the deviation of the given characteristic in the analog to the perennial amplitude of this characteristic, expressed in percent, the divergence of the analog and designate it D_i^a, where i is the year of the analog and a is the comparison year:

$$D_i^a = \frac{\Delta_i}{\Delta_{max}} 100\%$$

The divergence subtracted from 100% is called the degree of analogousness or simply the analogousness of the given analog and is designated by A_i^a, where a and i are used as in D:

$$A_i^a = 100 - (D_i^a), \text{ or } A_i^a = \left(1 - \frac{[\Delta_i]}{\Delta_{max}}\right) 100\%$$

A_i^a can vary from 100%, when the given characteristic in the analog agrees completely with its value in the comparison year, to 0, for deviation equal to the perennial amplitude, which holds when two extremal years are compared. The divergence D_i^a may also vary from 0 to 100% and may be positive or negative in dependence on the sign of Δ_i.

As an example, we will find the values D and A for several summer seasons when compared with the summer of 1946 using the frequency of an anticyclone field in the southern part of European USSR (Region 7 of the synoptic catalog) as the characteristic.

The number of days with anticyclones in this region was 65 in 1946. Laying out the 40-year series for comparison, we find the maximum number of days with anticyclones in the summer in Region 7 was 76 in 1938 and minimum was 25 in 1933, giving an amplitude of 50 days. The divergence of 1938 with 1946, which we designate as D_{38}^{46} is

$$D_{38}^{46} = \frac{76-65}{50} 100\% = 22\%$$

and the analogousness

$$A_{38}^{46} \left(1 - \frac{76-65}{50}\right) 100\% = 78\%$$

For 1933 we obtain:

$$D_{33}^{46} = \frac{26-65}{50} 100\% = 78\%$$

$$A_{33}^{46} = 100 - 78 = 22\%$$

In 1932, the number of days with anticyclones in Region 7 was 65; consequently, $D_{32}^{46} = 0$, $A_{32}^{46} = 100\%$.

D and A for each year can be calculated in the same way.

When evaluating analogousness for several characteristics, the values of D or A are calculated for each characteristic separately and then averaged, and the average of the absolute values of divergence is taken for D. Among the characteristics are the more important and less important; and, therefore, given sufficient cause, each characteristic may be given a definite weight in averaging. Conditional weights may of course be introduced, but then the evaluation also becomes conditional.

We used monthly, seasonal, and yearly data (for the preceding 12 months as well as for the calendar year) for the frequency of cyclone and anticyclone circulation and their intensity as characteristics for evaluating analogs. This data was calculated separately for each of the eight regions of the synoptic catalogue and then averaged for the entire natural Mul'tanovskiy synoptic region, which includes all these eight regions. When drawing up forecasts for the European part of the USSR, which includes Regions 4 and 7 of the synoptic catalogue, we give the data for these regions double weight, and thus the average divergence and the average analogousness for each characteristic is obtained by adding the data of the eight regions and dividing the sum by 10. The frequency of cyclone and anticyclone circulation is defined in days, and the number of days in the time interval under consideration is given in the sum. Thus, the frequency of cyclonic circulation may be found by knowing the number of days with anticyclones and vice versa.

Since the deviation of the number of days with cyclones or anticyclones in the analog from the corresponding number in the comparison year is used to determine the divergence or analogousness, and since this quantity Δ_i is divided by the perennial amplitude of the number of days with cyclones or anticyclones Δ_{max}, which number is identical for both types of circulation, the degree of analogousness is the same for both cyclones and anticyclones. Therefore, comparison with respect to one of the circulation types is sufficient in selecting analogs. If, in calculating D and A, we took the number of days with a given type of circulation in the comparison year instead of Δ_{max}, we would obtain different values of divergence and analogousness for cyclones and anticyclones.

The intensity of cyclones and anticyclones varies in a different manner, and thus analogousness evaluated with respect to intensity of circulation must be defined separately for cyclones and anticyclones. The indexes I_Z and I_A, previously introduced by the author in "Defining an Index of Circulation from the Data of a Synoptic Catalog," Meteorologiya i Gidrologiya, No 5, 1947 were used as measures of circulation intensity.

Intensity of cyclonic circulation is defined as:

$$I_z = \frac{6n_9 + 3n_8 + n_7}{n_9 + n_8 + n_7}$$

and intensity of anticyclonic circulation as

$$I_A = \frac{6n_0 + 3n_1 + n_2}{n_0 + n_1 + n_2}.$$

Here n_i is the number of days with the various indexes used in the synoptic catalog for the characteristic (intensity of pressure formations), n_0 the number of days with powerful anticyclones, n_1 the number of days with moderate anticyclones, n_2 the number of days with weak anticyclones, n_9 the number of days with deep cyclones, n_8 the number of days with moderate cyclones, and n_7 the number of days with weak cyclones.

For illustration, see the appended table for evaluating analogousness. This table gives the divergence of analogs with respect to the number of days with cyclones and anticyclones in the winter season (December - February) in comparison with the winter of 1946 - 1947, calculated from the formula

$$D = \frac{\Delta_i}{\Delta_{max}} 100\%$$

Values of D are given for each year for each region and averaged for all regions. The data for Regions 4 and 7 are given double weight. The values of A are given simply as 100 - D.

The averaged values of D and A show that the closest analog to the winter of 1946-47 for this characteristic is the winter of 1925-26, which showed a divergence of only 11% i.e., it was 89% analogous. Next comes 1928-29, with a divergence of 21%; and then 1918-19, with a divergence of 21%. The last year in the series is 1943-44, with a divergence of 60% or A = 40%.

Thus, we have obtained a comparative evaluation of all years and can place them in a series with respect to analogousness. On the other hand, since the values of D and A are expressed in percent of the perennial amplitude of the given characteristic, they can be compared with the same quantities in selecting analogs for other characteristics and other comparison years. We have a common measure for evaluating analogousness with respect to different characteristics and can, therefore, not only isolate various years as the best analogs but also indicate exactly what this means in each individual case.

Use of a homogeneous evaluation permits averaging of D and A for various characteristics. Moreover, from such a table we can always find the magnitude and sign of the deviation of the given analog from the comparison year in a certain region. For example, the divergence of the best analog, 1925-26, from the winter of 1946-47 is most pronounced in Regions 3 and 1, i.e., in the Taymyr region and in the lower parts of the Ob' River, on the one hand, and in the region of Iceland, on the other. This divergence appears in the greater frequency of cyclonic circulation in 1925-26 since the sign of D in these regions is negative.

In a detailed comparison of analogs, attention must be given to divergence with respect to individual regions. In some cases, decisive importance must be given to the data for a particular region, and not to the averaged evaluation of analogousness, depending on the problem.

The new characteristics introduced by the author for the selection of analogs substantially broaden the potentialities of the synoptic meteorologist who must draw up long-range forecasts. Homogeneous synoptic material for 40 years has been added to the atlases of anticyclone trajectories and maps of anomalies (although the latter are by no means available everywhere) which are used in operational practice of the Central Forecasting Institute and associated long-range weather forecasting groups. This material has been translated into numbers, making possible objective quantitative evaluation of analogousness, which distinguishes it favorably from the cartographic material customarily used, which is evaluated qualitatively and visually with high subjectivity. The pressure-circulation condition in this method is not a second-rate meteorological element, but must be included as a basic criterion for evaluating analogs, since it reflects the type and intensity of circulation, i.e., the most important indexes of the atmospheric process.

These characteristics were shown to be very important by the author's study of climatic variations for the past decade "Cyclones of the Northern Seas and Warming of the Arctic," Meteorologiya i Gidrologiya, No 5, 1946. These variations are well explained by variations of the circulation characteristics which we use. The representativeness of these characteristics as indications of the state of the atmosphere also accounts for their good correlation with fluctuations of solar activity (L. A. Vitel's, "Intensity of Atmospheric Circulation in the Arctic and Solar Activity," Meteorologiya i Gidrologiya, No 6, 1946).

Experience has shown that an analog selected for any certain month is generally not very reliable but analogs selected for seasonal or annual data have high reliability. It is therefore recommended that only annual and seasonal characteristics be used for long-range forecasts.

The following must be taken into consideration when using either of the latter.

A good analog year with respect to total or average yearly characteristics may be very poor when analogousness is evaluated for the individual seasons, but the reverse cannot hold. Consequently, the field of good analog years is larger than the field of years with high analogousness of all the seasons. In comparing the importance of the separate seasons, we consider that analogousness of the last seasons, generally speaking, must be given the highest evaluation; in other words, an analog with gradually increasing analogousness is more reliable than an analog which had good similarity three or four seasons back and lost it in the last one or two seasons.

From this standpoint, we could limit the selection of analogs to the last season or the last two seasons without taking more distant seasons or averaged yearly characteristics into consideration.

This problem requires basic study, however. When studying macroprocesses which develop over a period of many months, it becomes clear in many cases that the more distant months, and not the recent ones, are most important. Certain definite stages of the process, i.e., its main phases, are manifested, which give to the process characteristic features and definite direction. On the other hand, we also get to know the transitional stages which influence to a considerably lesser degree the process as a whole and may be different in monotypical macroprocesses.

Therefore, while stressing seasonal characteristics, and especially those of the most recent season, we must not neglect the characteristics of distant seasons and the entire preceding year as a whole. In some cases, even longer periods than a year must be taken into consideration.

To take into consideration the influence of both yearly and seasonal characteristics and give greater weight to the latter, particularly to the last season as compared with the yearly, we tentatively used the following method of averaging: the divergence, or analogousness, is evaluated from yearly data, from average data for the four seasons, and from the data for the last season. These evaluations are added and the sum divided by 3. By this averaging method, all seasonal characteristics are considered twice and the characteristics of the last season, three times. The method described above for the quantitative evaluation of the degree of analogousness can be applied to any quantitative characteristic, including the time of occurrence of various seasonal phenomena.

This same evaluation principle can also be extended to qualitative characteristics which are not expressed directly by number and to distribution of anomalies maps and trajectory maps. For this purpose, a method of arithmetization of these maps must be devised, i.e., a method of translating the main characteristics of the map into numerical indexes, similar to the method used by the author in compiling a synoptic catalog. Preliminary attempts in this direction have indicated the feasibility of such arithmetization and, consequently, the feasibility of objective quantitative comparison of maps.

Arithmetization of trajectory maps for various times, including natural synoptic periods and elementary synoptic processes, as well as of other types of maps used in drawing up long-range forecasts, will make possible mechanization of the iterative stages of work in selecting analogs. When all the basic data which serves as a criterion in selecting analogs is translated into quantitative indexes, it will be possible to compare them, in a single set, with a fully homogeneous approach to all elements to evaluate the degree of analogousness.

To this set of meteorological factors must be added one more very important criterion, the disregarding of which in selecting analogs is often the reason for completely unexpected failures of forecasts. Analogs, which are fully suitable according to a number of characteristics, may cause fundamental errors in the forecast due to the influence of solar activity. As works of recent years have indicated, especially those of Soviet scientists V. Yu. Vize, M. S. Eygenson, B. M. Rubasheva, P. P. Predtechenskiy and the author (L. A. Vitel's, "Cyclones of Northern Seas," Meteorologiya i Gidrologiya No 5, 1946; "Intensity of Atmospheric Circulation in the Arctic and Solar Activity," Meteorologiya i Gidrologiya, No 6, 1946), fluctuation of solar activity is one of the main regulators of large-scale atmospheric circulation. Consequently, solar indexes must be included in the basic characteristics for complete evaluation of analogs. What indexes of solar activity should be used and what weight should be given them must be developed after further study of this problem.

At present, we can recommend the use of three characteristics: (1) Wolf's sunspot numbers, which give the total number of spots; (2) the number of large spots, which separate the most geoactive of solar phenomena; and (3) the recurrency index of sunspot groups, which express the stability and range of solar disturbances. All these indexes are expressed quantitively and can be subjected to the same comparative evaluation with respect to degree of analogousness as the characteristics of the pressure-circulation regime.

[Appended table follows.]

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Divergence of Analogs with Respect to Number of Days with Cyclones and Anticyclones in the Winter Season (December - February) Compared with the Winter of 1946-47, Calculated from Formula $D = \frac{\Delta i}{\Delta_{max}} 100\%$

	Regions								Average	
Year	1	2	3	4	5	6	7	8	D	A
1900-01	- 3	-41	- 9	-75	17	25	-43	-22	35	65
1901-02	-40	-16	14	-88	23	- 7	-26	-57	38	62
1902-03	-40	-60	-34	-70	21	29	-49	-51	47	53
1903-04	-77	-43	-20	-22	15	-25	- 3	-27	26	74
1904-05	-57	-60	-66	-85	47	23	-37	-51	55	45
1905-06	-73	-57	- 6	-55	38	29	9	-11	34	66
1906-07	-80	-54	-37	-52	79	25	-26	5	44	56
1907-08	-70	-32	0	-85	23	2	-54	-35	44	56
1908-09	-87	-73	-71	-82	32	14	-26	-78	57	43
1909-10	-90	-76	-54	-62	51	-23	3	- 8	43	57
1910-11	-37	-60	- 6	-58	49	20	3	8	30	70
1911-12	-30	5	-43	-15	-49	13	34	-16	25	75
1912-13	-80	-27	-26	-75	-45	32	-49	-32	49	51
1913-14	-50	-19	- 6	-98	32	45	-14	-54	43	57
1914-15	-97	-27	17	-52	21	-34	11	8	33	67
1915-16	-57	11	-34	-65	47	- 5	-14	-22	33	67
1916-17	- 7	24	11	-65	17	-13	-23	- 3	25	75
1917-18	-67	-49	-34	-85	9	34	-14	- 5	40	60
1918-19	-43	-14	20	-40	-15	-14	6	-30	23	77
1919-20	-83	-43	-54	-68	40	16	3	0	38	62
1920-21	-77	-60	-69	-48	9	7	6	-41	37	63
1921-22	-97	-38	9	-50	43	- 5	-17	- 8	33	67
1922-23	-33	-22	-31	-48	28	7	-14	3	25	75
1923-24	-47	- 5	20	-25	68	11	17	0	24	76
1924-25	-90	-35	-31	-54	0	21	-25	-27	39	61
1925-26	-23	- 8	-34	-12	9	- 9	0	5	11	89
1926-27	-67	11	-23	-52	26	16	-17	11	29	71
1927-28	-17	-27	-57	-38	19	21	-17	-14	26	74
1928-29	-27	-24	-29	-22	13	14	-23	-11	21	79
1929-30	-37	-30	-54	-40	32	7	46	-32	36	64
1930-31	-30	-30	29	2	64	9	46	-27	28	72
1931-32	10	-32	-26	-80	26	61	-26	8	38	62
1932-33	-43	-38	26	-28	19	34	9	-49	28	72
1933-34	-13	-65	-71	-70	40	30	0	-51	41	59
1934-35	-57	-54	-31	-32	32	4	9	16	28	72
1935-36	-37	-22	29	-45	-21	-39	9	22	28	72
1936-37	-50	-16	-31	-50	-11	-16	-20	19	28	72
1937-38	-33	-35	20	-32	32	7	-37	-16	28	72
1938-39	-67	24	-40	-38	17	-11	20	0	28	72
1939-40	--	--	--	--	--	--	--	--	--	--
1940-41	--	--	--	--	--	--	--	--	--	--
1941-42	--	-22	-57	-28	--	--	-69	-14	41	59
1942-43	-17	-30	-77	-92	36	5	- 7	- 8	37	63
1943-44	-27	-73	-51	-95	85	32	-69	- 5	60	40
1944-45	-33	-41	-37	-40	77	- 7	20	-32	35	65
1945-46	-13	-27	3	-62	51	21	-63	-32	40	60

Positive figures indicate that the frequency of anticyclones in the given year was greater than in 1946-47 and, correspondingly, the number of cyclones was lower; the minus sign indicates the reverse. Data for Regions 4 and 7 were given double weight in computing the averages.

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